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Original Research

General surgeon's antibiotic stewardship: Climbing the Rogers Diffusion of Innovation Curve-Prospective Cohort Study

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HIGHLIGHTS

- The concordance of general surgeons with antibiotic stewardship programs is contentious.
- The Rogers Diffusion of Innovation Curve visualises the challenge of improving antibiotic governance amongst surgeons.
- General surgeons are disengaged with antibiotic governance.

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ABSTRACT

Introduction: The primary aim of this study was to establish concordance of general surgeon's prescribing practice with local IV-oral antibiotic guidelines. The secondary aim was to evaluate the effect of introducing educational antibiotic measures. The Rogers Diffusion of Innovation Model was used to explore the adoption of antibiotic stewardship practices.
Methods: In this prospective, cohort study, data was collected on 100 pre and 100 post awareness intervention programme patients. The educational intervention comprised raising awareness of a) the guidelines b) pre-intervention results c) introducing an IV-oral antibiotic prompt sheet. The concordance with local guidelines was compared between pre- and post-intervention groups using Fisher's Exact Test or Pearson's Chi Test (SPSS Statistics V22).
Results: The concordance of general surgical doctors with local IV-oral antibiotic guidelines was poor and did not improve significantly following the awareness intervention programme. There was no uptake of the antibiotic prompt sheet. There was a trend towards increase in the number of patients switched from IV to oral antibiotics at 48–72 h and significant increase ($p < 0.05$) in number of patients with clearly documented intention to review IV antibiotics.
Conclusion: Antibiotic governance measures failed to inspire even an initial group of innovators to use the antibiotic prompt sheets. It appears educational measures are effective in improving prescribing behavior and intent amongst a group of early adopters, but this fails to reach a critical mass. In order to improve antibiotic governance and embark upon the Rogers Diffusion of Innovation Curve, more must be done to engage general surgical doctors in timely, judicious antibiotic prescribing.

1. Introduction

Antibiotic stewardship is an education focused, healthcare system-wide approach to encourage appropriate prescribing and monitoring of antibiotics. Antibiotic stewardship is therefore a relevant topic for all surgical doctors, important in optimising patient clinical outcomes and protecting patient safety [1,2]. Here, we use the Rogers Diffusion of Innovation Model [3] to explore why innovations aimed at improving antibiotic governance are difficult to implement amongst surgical doctors.

Antibiotics are the most commonly prescribed hospital medication, of which 40% are administered intravenously [4]. Sequential antibiotic therapy has been advocated for many years, encouraging

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early switch from IV antibiotics to equivalent oral antibiotics [5–7]. This should be considered at around 2–3 days as this is when culture results and initial clinical course allow re-assessment [8,9]. The direct advantages of switching IV to oral antibiotics include reduced risk of IV catheter site infection, reduced length of hospital stay, increased patient comfort and mobility [10–13]. Indirect benefits include reduced time spent preparing, administering and monitoring injections. Early switch or oral antibiotics has additional associated cost savings [14], alongside the lower acquisition costs of oral formulations [11].

The compliance of surgeons with antibiotic stewardship programs (ASPs) remains contentious within contemporary existing literature. Knox and Edye [15] attempted to improve prophylactic antibiotic prescribing within an Australian general surgical department, but found an educational ASP to be ineffective. Similarly, Cusini et al. [16] reported higher rates of error and inappropriate antibiotic use within surgical wards at the University Hospital Zurich, as compared to medical firms. However, a number of studies support the efficacy of ASPs in improving adherence to antibiotic prophylaxis [17–19].

The engagement of surgeons with new antibiotic stewardship drives and practices can be framed using Roger's Diffusion of Innovation Curve [3]. This established change management model applies to human collectives adopting a new idea and maps the spread of innovative drives. This suggests there are 5 categories of adopters: innovators (2.5% of the collective), early adopters (13.5%), early majority (34%), late majority (34%) and finally the laggards (15%). Rogers further proposes that once a critical mass has been reached, further diffusion of innovation adoption becomes self-sustaining and inevitable. The Rogers Diffusion of Innovation Curve is a useful tool to consider when attempting to influence prescribing behavior; the diffusion and spread of an educational intervention innovation can be pinpointed by identifying where the participants sit on the curve at a given point in time. The model can also be helpful in explaining why ideas appear to gain momentum but fail to affect a whole group's behavior i.e. when a critical mass is not reached. This model is applied here as a framework to unpick the adoption of antibiotic educational programs.

The primary aim of this study was to establish concordance of general surgical doctor prescribing practice with local IV-oral antibiotic guidelines. The secondary aim was to evaluate the uptake of change by general surgical doctors, following introducing educational antibiotic measures. The null hypothesis was that an educational measure would have no change on prescribing behavior and that change measures would not be taken up.

2. Material and methods

2.1. Study design

This prospective cohort study was conducted in accordance with the STROBE statement [20]. Data was collected on 100 pre-awareness intervention programme (control arm: September 2015–February 2016) and 100 post-intervention patients (study arm: April–August 2016). Patients were identified prospectively and consecutively, on quasi-random data collection dates.

2.2. Participants and setting

The inclusion criteria for this study was general surgical patients on the general surgical ward of the local acute teaching hospital, aged >18 years, prescribed IV antibiotics during their current admission. Patients were excluded if the clinical condition indicated prolonged IV administration according to local hospital guidelines (i.e. meningitis/CNS infection, endocarditis, osteomyelitis/septic arthritis, bacteraemia, necrotising fascitis/severe cellulitis).

The local guidelines state that IV antibiotics should be switched to oral antibiotics at 48 h if the following 5 criteria are met; 1) temperature <38 °C for ≥24 h 2) clinical improvement observed 3) white cell count (WCC) and c-reactive protein (CRP) improving 4) haemodynamic stability 5) oral route viable.

2.3. Awareness intervention programme

The intervention (March 2016) consisted of an awareness intervention program, consisting of a) local hospital IV-oral switch guidelines b) pre-awareness intervention programme results c) introducing an IV-oral antibiotic prompt sheet (supplementary material 1). This was targeted at junior members of the general surgical team, most likely to be prescribing the antibiotics. This was achieved through email circulations, posters (supplementary material 2) and presentation at local meetings. The IV-oral antibiotic prompt sheet was designed for use for all general surgical patients started on IV antibiotics, prompting review of guideline criteria 1–5 at 48 h and also reminding prescribers to take bloods at day 0 and 2. This was made available in electronic form via emails and on shared computer drives, alongside physical hard-copies being made available in prominent places around the general surgical ward.

2.4. Variables

For included patients, patient clinical notes, drug charts and blood results were reviewed ≥72 h after IV antibiotics commenced. Patient demographics were recorded. The following primary data endpoints were noted; if the local hospital antibiotic IV-oral switch guideline criteria were fulfilled at 48 h (points 1–5) and if so, whether IV antibiotics were switched to oral at either 48 h or at 48–72 h. The reverse was also established.

Points 1 and 4 were collected from patient observation charts, points 2 and 5 from clinical notes and point 3 from patient electronic blood results. For the purposes of this study, WCC improvement was defined as a drop of $\geq 2 \times 10^9$/L and CRP improvement as a drop of ≥5 mg/L. Haemodynamic stability was defined as a systolic blood pressure ≥110 mmHg and a heart rate ≤90 and ≥ 50.

Secondary data endpoints were collected to establish supporting antibiotic prescribing parameters. For each patient, whether inflammatory blood markers had been taken on day 0 & 2 was documented (enabling point 3 to be established). In addition, it was noted whether or not there was an explicit documented intention to review the antibiotics in the patient notes. For all post-awareness intervention programme patients, the uptake of the antibiotic proforma was additionally noted.

2.5. Statistical methods

To detect a change in proportion of patients switching from IV to oral antibiotics from 25% in the pre-awareness intervention programme group to 45% in the post-intervention group at the 5% significance level, with 80% power, 89 patients per group would be required. The study size of total 200 patients (100 pre and 100 post awareness intervention programme) was chosen to allow for missing data. The concordance with IV antibiotic guidelines (primary endpoints) alongside supporting secondary endpoints was compared between pre- and post-awareness intervention programme groups. Fisher's Exact Test (2-sided) was applied where cells<5, and Pearson's Chi Test (2 sided) where cells>5. The clinical parameters were compared to establish confounding variables. All